

## 2017 Cobra Invitational – Div B Optics

### Optics (B)

Team Name: \_\_\_\_\_

Team #: \_\_\_\_\_

Student Names: \_\_\_\_\_

===== Don't Write Below this line =====

### Scoring:

#### Part I – Test Score:

Section A: \_\_\_\_\_/20

Section B: \_\_\_\_\_/30

Part I (A + B): \_\_\_\_\_/50

TS = (Part 1 / Part 1<sub>Max</sub>) \* 50 = \_\_\_\_\_/50

#### Part II – Laser Shoot:

MS (Mirror Score): \_\_\_\_\_/20

AS (Accuracy Score): \_\_\_\_\_/25

BS (Barrier Score): \_\_\_\_\_/5

Laser Shoot Score: \_\_\_\_\_/50

**Total Score: TS + MS + AS + BS = \_\_\_\_\_/100**

**Rank: \_\_\_\_\_**

**Part 1 Multiple Choice (Each questions = 1 point, Total = 20 points)**

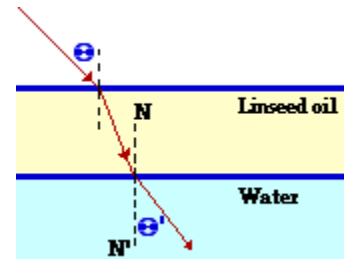
1. The relative index of refraction between two media is 1.50. Compared to the velocity of light in medium 1, the velocity of light in medium 2 will be
  - A. Greater by 1.5 times
  - B. Reduced by 1.5 times
  - C. The same
  - D. The velocity will depend on the two medium
2. Which phenomenon can occur with light, but not with sound?
  - A. Doppler effect
  - B. Interference
  - C. Polarization
  - D. Refraction
3. A ray of light is incident from a layer of crown glass ( $n=1.52$ ) upon a layer of water ( $n=1.33$ ). The critical angel of incidence for this situation is equal to
  - A. 61 degree
  - B. 51 degree
  - C. 40 degree
  - D. 30 degree
4. If the intensity of a monochromatic ray of light is increased while the ray is incident on a pair of narrow slits, the spacing between maxima in the diffraction pattern will be
  - A. increased
  - B. decreased
  - C. the same
  - D. increased or decreased, depending on the frequency
5. A spherical concave mirror is used in the back of a car headlight. Where must the bulb of the headlight be located to produce a parallel beam of reflected light?
  - A. Between the principal focus and the mirror
  - B. Beyond the center of curvature of the mirror
  - C. At the principal focus of the mirror
  - D. At the center of the curvature of the mirror
6. If the velocity of light in a medium depends on its frequency, the medium is said to be
  - A. dispersive
  - B. refractive
  - C. diffractive
  - D. resonant
7. Which of these electromagnetic waves has the shortest wavelength?
  - A. Infrared waves
  - B. Light waves
  - C. Radio waves
  - D. X-rays
  - E. Ultraviolet waves

8. A ray of light strikes a plane mirror at an angle of incidence equal to 55 degrees. The angle between the incidence ray and the reflected ray is \_\_\_\_.
- A. 55 degrees
  - B. 75 degrees
  - C. 105 degrees
  - D. 110 degrees
9. Different colors of light correspond to different light
- A. frequencies
  - B. polarities
  - C. velocities
  - D. intensities
  - E. None of the above
10. If sunlight were blue instead of white, the most comfortable color to wear on a hot day would be
- A. white
  - B. red
  - C. blue
  - D. green
  - E. black
11. A magnifying glass is a
- A. Diverging lens
  - B. Diverging and converging lenses
  - C. Converging lens
12. Which instrument is a human eye most similar to
- A. Camera
  - B. Magnify glass
  - C. Telescope
  - D. Microscope
  - E. projector
13. On a bright day, the iris of the eye changes so the pupil
- A. Becomes smaller
  - B. Becomes larger
  - C. Stays the same
14. Light in air approaches the boundary of oil at an angle of 45 degrees with respect to the normal. The light travels at a speed of  $2.27 \times 10^8$  m/s through the oil. Determine the angle of refraction.
- A. 32.3 degrees
  - B. 42.3 degrees
  - C. 37.3 degrees
  - D. 25.3 degrees
15. Mirrors on the passenger door usually say: "Objects in Mirror Are Closer Than They Appear." What type of mirror is this
- A. Plane

- B. Concave
  - C. Convex
  - D. Concave or Convex
  - E. None of them
16. When an object is placed in front of a plane mirror the image is:
- A. Inverted, demagnified and real
  - B. Inverted, magnified and virtual
  - C. Upright, magnified and virtual
  - D. Upright, magnified and real
  - E. Upright, the same size and virtual
17. An object is placed in front of a diverging lens. Where will the image appear?
- A. Only at the focal point.
  - B. At the surface of the lens.
  - C. On the same side of the lens as the object
  - D. On the opposite side of the lens
  - E. None of the above
18. When light enters a human eye it passes through number of different optically transparent organs before hitting the retina. They are, in the order that the light passes through the eyes:
- A. Cornea, anterior chamber, pupil, lens, Vitreous humor
  - B. Cornea, anterior chamber, lens, pupil, Vitreous humor
  - C. Anterior chamber, cornea, pupil, lens, vitreous humor
  - D. Cornea, anterior chamber, lens, pupil, Vitreous humor
  - E. Cornea, anterior chamber, iris, lens, pupil, Vitreous humor
19. The retina is made up of two different kinds of light sensitive cells. These cell are referred to as:
- A. Thin and wide
  - B. Long and short
  - C. Spheres and rods
  - D. Squares and rods
  - E. Rods and cones
20. The process by which light is divided into different wavelengths using a prism is called:
- A. Light division
  - B. Chromatic dilation
  - C. Chromatic inversion
  - D. Chromatic dispersion
  - E. Chromatic reversion

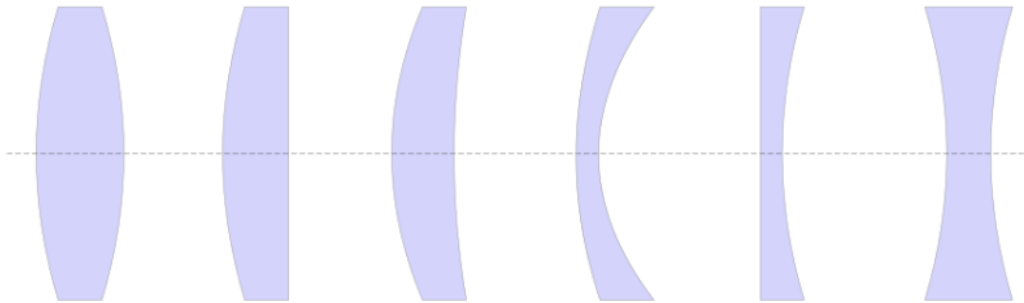
**Part 2 Problems (Total = 30 points)**

1. The diagram at the right shows a ray of light traveling through air towards a thin layer of linseed oil ( $n = 1.50$ ) resting on top of water ( $n=1.33$ ). The light ray approaches the linseed oil at an angle of incidence of  $45^\circ$ . (3 points)
  - a. Determine the angle of refraction at the air-linseed oil boundary. (1 Points)
  - b. Determine the angle of refraction at the linseed oil-water boundary. (2 Points)



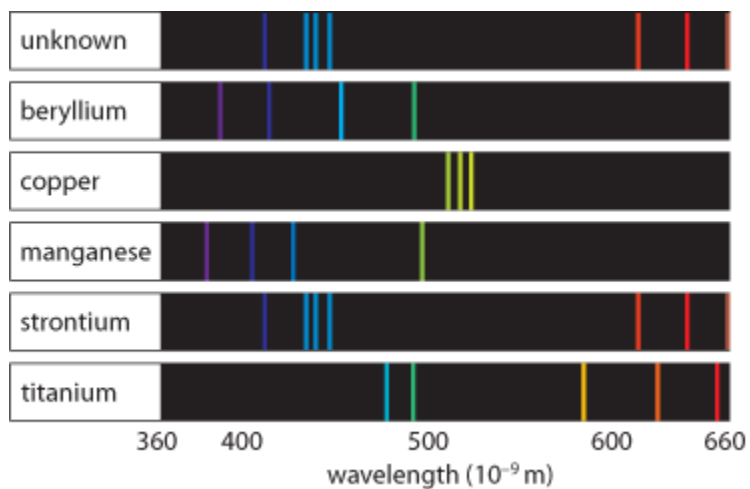
2. An object is 40 cm in front of a converging lens with a 5 cm focal length. A second converging lens, with a focal length of 2 cm, is placed 8 cm behind the first one. (3 points)
  - a. Locate the image formed by the first lens (1 Point)
  - b. Locate the image formed by the second lens if the first image is used as an "object" for the second lens (1 Point)
  - c. What is the combined magnification of this combination of lens (1 Point)
3. An observer recorded the wavelength of Hydrogen spectrum of 21.110 cm verse the normal 21.106 cm from a far away star (3 points)
  - a. Is the star traveling away or toward the observer? (1 Point)
  - b. Is this redshift or blueshift? (1 Point)
  - c. How fast is the star traveling? (1 Point)

4. Please provide the official name for these lens (3 points)



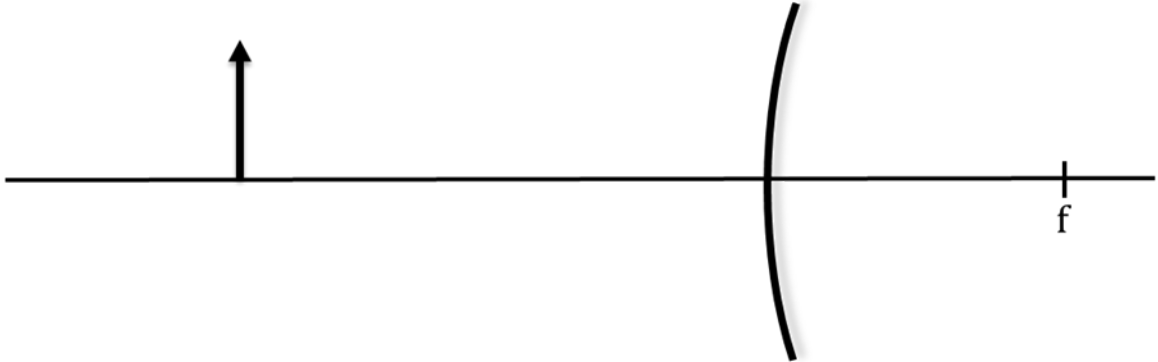
5. Radio has AM and FM Stations. Two of the most popular stations are AM950 and FM 97.1. The AM 950 has frequency of 950kHz and FM 97.1 has frequency of 97.1Mhz. (3 points)
- What is the wave length for AM950? (1 point)
  - What is the wave length for FM97.1? (1 point)
  - How many times is the wave length for AM950 verses FM97.1 (1 point)

6. A composition of a crushed rock sample was investigated using spectroscopy. After dissolving in acid the rock sample solution was heated to produce a spectrum. Shown below is this spectrum, along with those of five metals. (3 points)

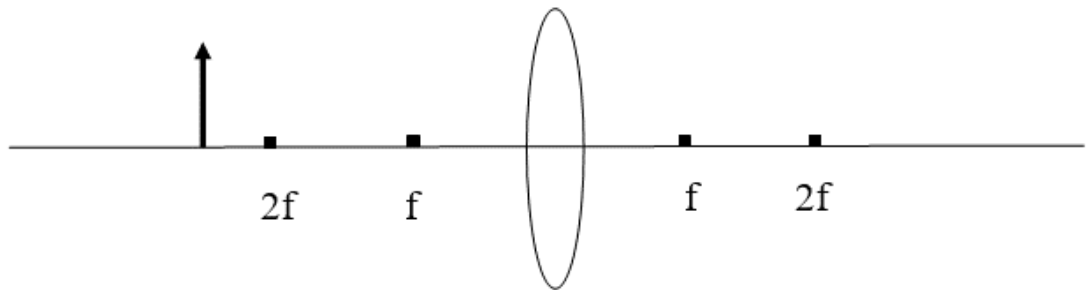


- What type of spectrum is this? (1 point)
- Based on this spectral analysis it can be concluded that the rock sample contains what type of metal? (2 points)

7. Show the ray diagram for the convex mirror and object below (3 points)



8. Show the ray diagram for the convex lens and object below. (3 points)



9. A Convex mirror has a focus of 10 cm, what is the radius for the convex mirror? (3 points)
10. Light is incident on a piece of flint glass ( $n = 1.66$ ) from the air in such a way that the angle of refraction is exactly half the angle of incidence. What are the values of the angles of incidence and refraction? (3 points)